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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/615,362	07/08/2003	Hee-Sook Park	5649-1055	8781

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MYERS BIGEL SIBLEY & SAJOVEC
PO BOX 37428
RALEIGH, NC 27627

EXAMINER	
TSAI, H JEY	

ART UNIT	PAPER NUMBER
2812	

DATE MAILED: 05/04/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/615,362	PARK ET AL.	
	Examiner	Art Unit	
	H.Jey Tsai	2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 February 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *14-26* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *14-26* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Election/Restriction

Applicant's election without traverse of claims 14-26 filed on Feb. 19, 2004 is acknowledged.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 14-15, 17-18, 20, 22-24 and 26 are rejected under 35 U.S.C. § 102(b) as being anticipated by Givens et al. 6,091,148.

Givens discloses a method of forming a metal contact in a semiconductor device, which includes:

forming an insulating layer 18 having a contact hole 28 therein on a silicon substrate 12, fig. 1+ and col. 10, lines 13+,

forming a PVD cobalt layer 34 on a bottom and inner walls of the contact hole 28, fig. 2 and col. 11, lines 1-14,

forming a cobalt silicide layer 36 at the bottom of the contact hole 28 while forming a titanium nitride layer 38 on the cobalt layer 34, col. 11, lines 58-68 and fig. 3,

forming a plug 44 on the titanium nitride layer 38 so as to fill the contact hole, fig. 4,

titanium nitride (refractory nitride) is used to assist in filling the contact, hence, titanium nitride is a part of plug 44, see abstract,

titanium nitride thickness is 20-200 angstroms (convert all unreacted titanium layer into titanium nitride layer), col. 12, lines 35-41 and col. 11, lines 45-49,

cobalt layer and titanium nitride layer are formed in situ without a vacuum break, col. 11, lines 1-14,

cleaning the insulating layer, col. 10, lines 54-68.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 16, 19, 21 and 25 are rejected under 35 U.S.C 103 as being unpatentable over Givens et al. as applied to claims 14-15, 17-18, 20, 22-24 and 26 above, and further in view of Kamoshima et al. 2002/0093097 and Zhao et al. 6,297,555.

The difference between the references applied above and the instant claim(s) is: Givens teaches forming cobalt silicide while forming titanium nitride with example of coating thickness and temperature but does not teach the specific range of coating thickness and temperature. However, Kamoshima teaches at para. 53 and 57, forming a CVD TiN on the cobalt (Co) film about 500° C to form a cobalt silicide and Zhao et al teaches at col. 5, lines 25-33, forming titanium nitride at about 340-500 degree C with thickness about 20-200 Angstroms and the specific coating thickness and temperature of cobalt and titanium layers as claimed are taken to be obvious since these are variables of art recognized importance which are subject to routine experimentation and optimization and discovery of an optimum value for a known process is

obvious. In re Aller, 105 USPQ 233 (CCPA 1955). And, even if applicants' modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within the capabilities of one skilled in the art, In Re Sola 25 USPQ 433.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the above references' teachings with specific coating thickness and temperature of titanium nitride and cobalt as taught by Kamoshima et al. and Zhao et al. because forming titanium nitride at higher temperature such as 400-500 degree C would cause cobalt layer to form a cobalt silicide in the bottom of contact hole and the thickness can be adjusted to obtain an optimum resistance for the cobalt silicide.

Claims 14-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kamoshima et al. 2002/0093097 in view of Givens et al. 6,091,148.

The reference(s) teach the features:

Kamoshima substantially discloses a method of forming a metal contact in a semiconductor device, which includes:

forming an insulating layer 21 having a contact hole 19 therein on a silicon substrate 20, fig. 10+ and para. 58+,

forming a cobalt layer 33 (see last two lines of para. 57, a TiN formed on a Co layer) on a bottom and inner walls of the contact hole 19, see fig. 10,

forming a cobalt silicide layer at the bottom of the contact hole 19 while forming a titanium nitride layer 33 on the cobalt layer 33, (note: CVD TiN is formed at temperature about 500 degree C, which is within the temperature range as disclosed in the instant invention to form

a cobalt silicide, hence, obviously during Kamoshima's titanium nitride deposition on the cobalt layer would form a cobalt silicide in the bottom of contact hole 19),

forming a plug 7 on the titanium nitride layer 33 so as to fill the contact hole, fig.9,

titanium nitride (refractory nitride) is used to assist in filling the contact, hence, titanium nitride is a part of plug 44.

The difference between the reference(s) and the claims are as follows: Kamoshima et al. teaches forming CVD TiN film on the cobalt film at about 500 degree C but does not teach the thickness of TiN and cobalt film is formed with PVD. However, Given et al. teaches at col. 13, lines 8-35 and col. 11, lines14, col. 11, lines 1-14, col. 10, lines 54-68, the thickness of TiN is 100 to 500 Angstroms and cobalt film is deposited with PVD with thickness at 800 angstroms, cobalt layer and titanium nitride layer are formed in situ without a vacuum break, cleaning the insulating layer.

And, specific coating thickness of cobalt and plug layers as claimed are taken to be obvious since these are variables of art recognized importance which are subject to routine experimentation and optimization and discovery of an optimum value for a known process is obvious. In re Aller, 105 USPQ 233 (CCPA 1955). And, even if applicants' modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within the capabilities of one skilled in the art, In Re Sola 25 USPQ 433.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified Kamoshima's process with specific thickness of CVD TiN, depositing cobalt film with PVD chamber without breaking the vacuum and cleaning the insulating layer before TiN and Co depositions as suggested by Givens et al. because specific

thickness of TiN nitride would form an optimum resistivity in the contact hole, PVD cobalt layer is a simply method for deposition without breaking the vacuum so that there is no oxide film formed on cobalt film before the deposition of TiN film and cleaning the insulating layer would also clean the contact hole so that cobalt film can adhere to the substrate in the contact hole.

Any inquiry of a general nature or clerical matters or relating to the status of this application or proceeding should be directed to the Group customer service whose telephone number is 571-272-1626.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to H. Jey Tsai whose telephone number is (571) 272-1684. The examiner can normally be reached on from 7:00 Am to 4:00 Pm., Monday thru Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling can be reached on (571) 272-1679. The fax phone number for this Group is (703) 872-9306.

hjt

4/22/04

H. Jey Tsai
Primary Examiner
Patent Examining Group 2800